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SUGGESTIONS FOR THE PREVENTION OF INFESTATIONS
OF CULTIVATED MUSHROOMS BY INSECTS AND OTHER PESTS

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Damage caused by mushroom flies, mites, and other pests can be reduced to a considerable extent by the use of certain precautionary measures before the compost is put into the house and during the process of its heating in the beds. Mushroom mycelium is very sensitive to most chemicals, and, furthermore, it is difficult to kill mushroom pests in the beds, as the chemicals used for their control do not penetrate the compost readily. It is, therefore, essential that every effort possible be made to rid the compost and houses of insects and other pests before the beds are planted and to prevent infestation during the cropping season. Recent studies have shown that the measures given below, if carefully followed, will be of material benefit.

In the first place, all spent compost should be removed from the house as soon as the beds have stopped producing and should be utilized as far away from the houses as possible. It should never be used immediately in greenhouses where workmen are likely to walk over it before entering the mushroom houses, as mites are likely to be carried from it into the mushroom house on the workmen's shoes. The area upon which the manure is composted should be well drained, thoroughly cleaned of all rubbish, and sprayed with a 5 per cent solution of formaldehyde, prior to the unloading of any fresh manure.

Composting.--Straw should be added to short manure and all lumps or cakes of manure well shaken out or broken up. The compost heap should be kept well ricked up during the composting, especially after the second and third turnings, in order that as little surface as possible may be exposed to insects and the weather. Avoid having the compost too wet, especially after the third turning.

Filling the house.--The house should be fumigated before filling by burning sulphur at the rate of 6 pounds per 1,000 cubic feet of air space. This fumigation should be sufficient to free the house of any mites or insects which may have lived over the previous cropping season. The sulphur can be burned in a 50-gallon oil drum cut in half the long way, or in specially made galvanized or sheet-iron trays, so that the molten sulphur will not flow and set fire to the house. Two pieces of wood, such as plaster lath, should be placed crosswise in the bottom of the container to admit more air to the burning sulphur. The rapidity and thoroughness in burning can be greatly aided by placing pieces of crumpled paper down the center of the container and then pouring the sulphur along each side of the row of paper.

Fill the house as quickly as possible, clean up all loose compost in the alleyways, and close the house as tightly as possible. If the weather is cool when the compost is ready to go into the house, the house should be heated before the compost is placed in it. This is especially important where the compost is very short, over-composted, or too wet. If the compost, after being placed in the house, goes through the proper heating process, the higher temperatures obtained at this time should either drive all animal life to the surface of the compost where fumigants will be effective, or kill it. Therefore everything possible should be done to raise the temperature of the beds as high as practicable and also to distribute the heat evenly throughout the house. As a general rule, the temperature in the lower bed does not go high enough to kill the pests or to drive them to the surface of the compost. This, however, can be corrected by raising the lower bed from 4 to 6 inches off the ground. If this can not be done, do not fill the bed, as it will only prove a breeding ground for mites and flies which will infest the rest of the house. An accurate soil thermometer should be placed in the bottom and top beds and the temperatures observed regularly. The compost in the top bed will heat up more quickly than that in the bottom bed, because the top beds are the last ones filled and the compost does not, therefore, lose much of its latent heat before the house is closed. The temperature of the compost in the top bed is also increased by the warm air which rises to the top of the house and remains there unless distributed by forced circulation. The bottom beds, unless aided by forced circulation, are generally slow to heat up and frequently do not get hot enough to rid them of excessive moisture and to kill the insects and mites which are almost invariably present in the compost.

Forced-air circulation.--The result of experiments on forced air circulation show that electric fans may be used to advantage to distribute the hot air about the beds evenly. This method can be utilized by the majority of growers with a little added expense if their houses are equipped with electricity, thus equalizing both the air and compost temperatures. In general the air temperature can be practically equalized all over the house and the compost temperature in the bottom bed can be brought to within 10° to 15° of that of the top beds. This is true, however, only when the bottom bed is raised off the ground. In some cases observed, where the bottom bed was raised off the ground, the compost temperature in these beds was brought to within 2° of the temperature in the top beds.

Method of circulating the air.--Use three 16-inch oscillating electric fans for a 50 to 75 foot single house. Place the fans in the filling alleyway facing the beds, and point the fan blades upward at an angle of 45° . Place the fans in the house as soon as it has been filled and closed, and distribute them at equal distances from one another in the filling alleyway. When the temperature of the compost in the top bed reaches 125° to 130° F., start

the fans and allow them to run from 8 to 10 hours. After the fans have been off for an hour or two to allow the heat in the top bed to build up, the fans should again be started. This process should be continued until all excess moisture has been dried out of the compost. Care should be exercised to prevent burning.

Fumigation.--Since the air temperature in a mushroom house is generally 15° to 20° below the temperature of the compost, insects and mites which are driven to the surface of the compost survive in this lower air temperature. Hence it is very important that the house be fumigated at the time the compost is at its peak heat.

Calcium cyanide.--For several years calcium cyanide at the rate of 1 pound to 1,000 cubic feet of air space has been customarily used for this fumigation. Owing to the conditions of high humidity and temperature in the house at this time, the hydrocyanic-acid gas is liberated from calcium cyanide very rapidly. Experimental work has shown that the maximum concentration of the gas is obtained within 15 minutes after scattering the granulated form of calcium cyanide in the alleyways. In view of the rapid evolution of this very poisonous gas, the calcium cyanide should be scattered in the alleyways as quickly as possible, the house vacated immediately, and left closed over night. Do not scatter calcium cyanide in the alleyways where there are puddles of water, as much of the value of the material will be lost through combination of the gas with the water. Fumigate if possible when there is little air movement. If the adjoining house is in a bearing stage, fumigate only when the wind is blowing away from it, as the gas might be carried from the house which is being fumigated into the bearing house and cause considerable damage. If the adjacent house is part of the double house being fumigated, the ventilators in the bearing house should be closed and the doors opened. If it is not a part of the house being fumigated, then both the doors and ventilators should be opened, weather permitting.

Sulphur.--The practice of burning flowers of sulphur when compost is at peak heat in the house, while not as generally practiced as cyanide fumigation, was used by several eastern and midwestern growers during the past season. Sulphur fumigation is much cheaper than cyanide fumigation and is apparently more effective on mites than cyanide. Sulphur fumigation has a tendency to increase slightly the acidity of the surface compost and especially on the top beds where condensation of the moisture occurs and where more of the sulphur fumes are absorbed. A greenish mold sometimes follows sulphur fumigation and it has been the observation of some growers that this mold is more pronounced in cases where the compost was cooled down too quickly after it had reached its peak heat in the beds. However, results of several yield tests showed that sulphur fumigation did not have any deleterious effect on the compost for subsequent mushroom culture.

Do not use over 2 pounds of flowers of sulphur per 1,000 cubic feet of air space, and do not leave the house closed for over 5 hours after all the sulphur has burned. The sulphur should be burned in the same manner as stated in a previous paragraph, and the same precautionary measures taken to prevent injury to growing mushrooms in adjacent houses as in cyanide fumigation.

After fumigation.--After the compost has been properly heated and fumigated every precaution should be taken to prevent reinfestation. Flies are generally present in compost heaps, therefore it is a good plan to screen all doors and ventilators with 30-mesh copper wire screen to prevent the entrance of these pests into the house. Flies also very frequently migrate from adjacent infested houses which are in the cropping state to a newly filled house before the casing soil has been placed on the bed. They also carry injurious mushroom mites into the house, the mites clinging to the legs and bodies of the flies. Keep a diligent watch for flies and other pests at least until the house has been cased.

When a few flies appear, dust the house twice a week, using $2\frac{1}{2}$ ounces of pyrethrum dust per 1,000 cubic feet of air space, and keep the house closed over night after dusting. A dust containing about 60 per cent of ground flowers of pyrethrum and 40 per cent of finely ground clay remains suspended in the air longer and has proved more effective than the pure ground pyrethrum flowers.

The placing of panes of glass about 6 by 8 inches in dimension in the doors in the southern or eastern end of the house has proved a satisfactory method for attracting flies even before they have laid all of their eggs. The flies may be caught by covering the lower half of the door with a sheet of heavy wrapping paper coated with sticky tree-banding material. The section of the paper that would cover the glass pane should be cut out before the sticky material is applied. If the house is over 50 feet long, panes of glass should be placed in each door.

Do not use kerosene or any oil as a spray in connection with mushroom culture after the compost is in the house, as it is likely to cause serious injury. The rapid multiplication or development of insect and mite life in the house during the cropping period can be decreased by keeping the house well ventilated and by keeping the air temperature below 55° F.